

菝葜科种皮微结构特征及其分类学意义

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Seed coat morphology of Smilacaceae and its systematic significance

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Abstract Macromorphology of seeds and micromorphology of the seed-coat in 53 species and 5 varieties belonging to three genera (*Smilax*, *Heterosmilax* and *Ripogonum*) of Smilacaceae were observed under the light microscope and the scanning electron microscope (SEM). The seeds are spheroidal, hemispheroidal or trigonal-oblate in shape. Under SEM high diversity was found in seed-coat micromorphology. Based on ornamentation of epidermal cells of the seed-coat, seven morphological types can be distinguished, viz., roughly rugulate, rugulate, reticulate, fine reticulate, foveolate, dense foveolate, and fine striate. Discriptions of seed size, shape and seed-coat types are summarized for the family. Taxonomic and phylogenetic implications of the seed-coat micromorphology are also discussed, in relation to the circumscription of traditional genera and sections of the family. Evidence from seed-coat micromorphological features supports placement of *Ripogonum* outside Smilacaceae and inclusion of *Heterosmilax* in *Smilax*, which are also consistent with palynological and molecular evidence. Within *Smilax*, seed-coat micromorphological features suggest close relationships between most of the species of sect. *China* and sect. *Macranthae*, and among sect. *Coprosmanthus*, sect. *Coilanthus*, and *Heterosmilax*. However, we found no support for the recognition of Koyama’s six proposed sections of *Smilax*.

Key words *Smilax*, *Heterosmilax*, *Ripogonum*, micromorphology, SEM, taxonomy.

摘要 在光学显微镜和扫描电镜下对菝葜科Smilacaceae 3个属(菝葜属*Smilax*、肖菝葜属*Heterosmilax*和*Ripogonum*属)共53种5变种植物的种子形态及种皮微形态特征进行了研究。结果表明其种子形状为球形、半球形或钝三角形。在扫描电镜下种子表皮纹饰可分为7种类型,即脑纹型、粗脑纹型、网纹型、细网纹型、孔穴型、密孔穴型和细条纹型。根据种皮微形态的特征,对菝葜科内属间和属内组间的关系进行了探讨。种皮形态分析结果支持将*Ripogonum*属从菝葜科中分离、独立成科,支持将肖菝葜属与菝葜属合并的观点,这与孢粉学和分子证据的分析结果一致;推测肖菝葜属和菝葜属的土茯苓组sect. *Coilanthus*及草本组sect. *Coprosmanthus*的多数种类之间亲缘关系较近,菝葜组sect. *China*和圆锥组sect. *Macranthae*的大多数种类之间的亲缘关系较为密切,但种皮形态证据不支持Koyama将菝葜属分为6个组的观点。

关键词 菝葜属;肖菝葜属; *Ripogonum*; 微形态; 扫描电镜; 分类学

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菝葜科Smilacaceae是单子叶攀援植物中种类最多的科之一, 包括菝葜属*Smilax* L.、肖菝葜属*Heterosmilax* Kunth和*Ripogonum* J. R. Forst. & G. Forst.三个属, 约有370种 (Heywood, 1993), 全世界热带、亚热带和温带均有分布。该科植物雌雄异株, 部分种类开花较为罕见, 而且居群内的表型变异大, 部分种间性状有时呈连续状, 导致种的鉴别较为困难, 还有很多分类学问题尚未解决。Koyama(1960, 1984)对东亚和东南亚地区的种类做了研究, 将菝葜属分为6个组, 并将肖菝葜属修订为12个种。但是这两个属的关系和菝葜属的分组是否自然等问题尚存疑问。*Ripogonum*属种类很少, 仅在澳大利亚附近有分布; Conran(1985, 1987)曾多次质疑它在菝葜科内的分类地位。最近我们从染色体核型、形态学、孢粉学以及分子系统学方面对菝葜科及其相关类群进行了研究(傅承新等, 1990, 1993, 1995; Fu et al., 2005; 陈士超等, 2006; Cameron & Fu, 2006; Chen et al., 2006)。种子作为繁殖器官具有相对稳定性, 其形态特征对分类学的重要性很早就被植物学家所认识 (Hooker & Thomson, 1860), 近年来应用种皮特征成功解决分类学问题的例子有很多, 例如对玄参科Scrophulariaceae婆婆纳属 *Veronica* L. (Martinez-Ortega & Rico, 2001)、石竹科Caryophyllaceae (Yildiz, 2002)、十字花科Brassicaceae (Abdel Khalik & Van der Maesen, 2002)、Hyacinthaceae科Massonieae族 (Pfosser et al., 2003)和凤仙花科Balsaminaceae 凤仙花属*Impatiens* L. (Song et al., 2005)的研究, 但是菝葜科植物的种子形态研究目前尚未见报道。本文对该科所包括的3个属近60种的种子形态进行了研究, 观察了其种子外部形态和种皮微形态特征, 旨在丰富、完善对菝葜科植物的认识, 并为该科植物分类研究和亲缘关系的探讨提供种子的形态学依据。

1 材料和方法

本研究所用材料多数来自中国科学院北京植物研究所标本馆(PE)和中国科学院昆明植物研究所标本馆(KUN)的馆藏标本, 还有部分新鲜材料来自野外采集的植株和移栽至浙江大学植物园内的植株, 该部分凭证标本现存于浙江大学植物标本馆(ZHU)。材料来源详见表1。本研究取样涵盖了该科的大多数国产种类, 包括了全部的属和绝大多数组(仅缺多蕊组sect. *Pleiosmilax* (Seem.) A. DC.的代表种, 具有较充分的代表性。但是由于材料取样的限制, 所获得国外的材料很少, 仅有采自美国、澳大利亚和印度尼西亚的少数种类

的种子。

将成熟果实的果皮剥离, 然后用20% NaClO浸泡处理种子以去除种皮上粘附的果肉, 取出后用毛笔轻轻刷去种皮表面的杂质(但不能损坏种子发育中自然形成的表面结构), 放置在吸水纸上自然干燥。置体视显微镜下, 观察种子形状、颜色并测量种子大小, 每个种类随机选取5粒成熟的种子用于尺寸测量。种子形态术语依据如下标准: 种子形状是指种脐朝下摆放时种子最大表面轮廓的形状; 大小以长×宽×厚表示, 用卡尺测量。长度指种子着生种脐的一端至另一端间(或着生种脐的一面至种子相对的另一面间)的最大距离; 宽度指垂直于长度轴的种子最大直线距离; 厚度指垂直于宽度的第三平面的直线距离 (Musil, 1978)。宽度和厚度都测量种子的最大部位。着生种脐的部位为腹部, 与腹部相对的部位为背部, 垂直于腹部和背部的两个面均为侧面。微形态特征描述的术语依据 Anderberg(1994)。

表1 菝葜科植物种子形态特征和材料来源
Table 1 The morphological characters of seeds in Smilacaceae and source of materials

分类群 Taxon	采集地 Locality	凭证标本 Voucher	种子形状 Shape of seed
类菝葜 <i>Ripogonum discolor</i> F. Muell.	澳大利亚悉尼 Sydney, Australia	傅承新(C. X. Fu) 98020 (HZU)	近球形 subspheroidal
短柱肖菝葜 <i>H. yunnanensis</i> Gagnep.	中国四川峨眉山 Mt. Emeishan, Sichuan, China	傅承新(C. X. Fu) 88322 (HZU)	近球形 subspheroidal
肖菝葜 <i>H. japonica</i> Kunth	中国云南屏边 Pingbian, Yunnan, China	蔡希陶(H. T. Tsai) 60973 (PE)	近球形 subspheroidal
华肖菝葜 <i>H. chinensis</i> Wang	中国广西龙津 Longjin, Guangxi, China	丁志遵, 汪嘉熹(C. T. Ting & J. X. Wang) 303515 (PE)	圆球形 spheroidal
白背牛尾菜 <i>Smilax nipponica</i> Miq.	中国贵州, 具体地点不详 Without precise locality, Guizhou, China	曹子余(Z. Y. Cao) 1183 (PE)	近球形 subspheroidal
牛尾菜 <i>S. riparia</i> A. DC.	日本大阪 Osaka, Japan	傅承新(C. X. Fu) 961001 (HZU)	近球形 subspheroidal
尖叶牛尾菜 <i>S. riparia</i> var. <i>acuminata</i> (C. H. Wright) F. T. Wang & T. Tang	中国湖北, 具体地点不详 Without precise locality, Hubei, China	李洪钧(H. J. Li) 5654 (PE)	近球形 subspheroidal
<i>S. herbacea</i> L.	美国, 具体地点不详 Without precise locality, USA	采集人不详 Anonymus	近球形 subspheroidal
华东菝葜 <i>S. sieboldii</i> Miq.	中国浙江, 具体地点不详 Without precise locality, Zhejiang , China	邓懋彬(M. B. Deng) 3914 (PE)	圆球形 spheroidal
短梗菝葜 <i>S. scobinicaulis</i> C. H. Wright	中国四川峨眉山 Mt. Emeishan, Sichuan, China	傅承新(C. X. Fu) 92051 (HZU)	近球形 subspheroidal
小果菝葜 <i>S. davidiana</i> A. DC.	中国浙江, 具体地点不详 Without precise locality, Zhejiang, China	陈涛 (T. Chen) 3084 (PE)	近球形 subspheroidal
菝葜 <i>S. china</i> L.	中国云南屏边 Pingbian, Yunnan, China 韩国釜山 Pusan, Korea	王启无(C. W. Wang) 88478 (PE); 傅承新(C. X. Fu) 96051 (HZU)	近球形 subspheroidal
日本菝葜 <i>S. biflora</i> Siebold ex Miq.	日本, 具体地点不详 Without precise locality, Japan	采集人不详 Anonymus	圆球形 spheroidal
三脉菝葜 <i>S. trinervula</i> Miq.	中国江西, 具体地点不详 Without precise locality, Jiangxi, China	关克俭(K. C. Kuan) 77058 (PE)	近球形 subspheroidal
长托菝葜 <i>S. ferox</i> Wall. ex Kunth	中国四川金佛山 Mt. Jinfoshan, Sichuan, China	傅承新(C. X. Fu) 92010 (HZU)	近球形 subspheroidal
柔毛菝葜 <i>S. chingii</i> Wang & Tang	中国云南, 具体地点不详 Without precise locality, Yunnan, China	王启无(C. W. Wang) 66983 (PE)	近球形 subspheroidal
红果菝葜 <i>S. polycolea</i> Warb.	中国广西, 具体地点不详 Without precise locality, Guangxi, China	陈少卿(S. H. Chun) 14559 (PE)	近球形 subspheroidal
武当菝葜 <i>S. outanscianensis</i> Pamp.	中国湖北, 具体地点不详 Without precise locality, Hubei, China	刘瑛(Y. Liu) 530 (PE)	近球形 subspheroidal

大小(长×宽×厚) Size (L×W×T) (μm)	种皮(纹饰)微形态特征 Micromorphological features of seed coat	图 Figure
6.0–8.0×5.8–7.6 ×6.2–8.3	种皮纹饰为粗脑纹型, 沟裂窄深, 脊上具不规则波纹 Seed-coat sculpture roughly rugulate, colpi deeply narrow in shape, muri with irregular ripple.	1, 4
3.5–5.4×3.5–5.2 ×4.0–6.2	种皮纹饰为脑纹型, 沟裂较浅, 脊表面光滑, 无表皮细胞界线。 Seed-coat sculpture rugulate, colpi shallow in shape, muri with smooth surface and without borderline of epidermal cell.	
3.8–5.5×4.3–6.6 ×3.5–5.8	种皮纹饰为脑纹型, 沟裂较深, 脊宽约60 μm, 表面光滑。 Seed-coat sculpture rugulate, colpi relatively deep in shape, muri ca. 60 μm wide and with smooth surface.	2, 5
3.9–6.0×4.0–5.8 ×4.2–6.6	种皮纹饰为脑纹型, 沟裂较深, 脊宽约60 μm, 高度起伏不定。 Seed-coat sculpture rugulate, colpi relatively deep in shape, muri ca. 60 μm wide with variational height.	
2.8–5.3×2.5–4.8 ×2.8–4.9	种皮纹饰为脑纹型, 沟裂细窄, 脊表面光滑。 Seed-coat sculpture rugulate, colpi narrow in shape, muri with smooth surface.	
2.5–4.2×2.4–4.5 ×2.4–4.2	种皮纹饰为脑纹型, 沟裂细窄, 脊表面光滑。 Seed-coat sculpture rugulate, colpi narrow in shape, muri with smooth surface.	3, 6
3.8–6.0×3.9–6.2 ×3.7–6.4	种皮纹饰为脑纹型, 沟裂浅, 脊表面光滑。 Seed-coat sculpture rugulate, colpi shallow in shape, muri with smooth surface.	
2.6–4.8×2.2–3.5 ×2.0–4.2	种皮纹饰为细网纹型, 网脊纵横垂直, 网眼较浅, 方形或圆形。 Seed-coat sculpture fine reticulate, muri vertically and horizontally interlaced, lumina relatively shallow and nearly quadrate or round in shape.	
3.9–5.4×3.8–5.5 ×3.8–5.7	种皮纹饰为网纹型, 网眼近圆形, 脊光滑, 表皮细胞连接处微隆起, 界线可见。 Seed-coat sculpture reticulate, muri with smooth surface, lumina nearly round in shape, joint of epidermal cell slightly projecting with borderline.	
4.6–6.3×4.4–6.7 ×4.4–6.5	种皮纹饰为网纹型, 网眼近圆形, 脊光滑, 表皮细胞连接处微隆起, 界线可见。 Seed-coat sculpture reticulate, muri with smooth surface, lumina nearly round in shape, joint of epidermal cell slightly projecting with borderline.	
3.0–5.2×3.0–5.1 ×3.1–5.4	种皮纹饰为网纹型, 网眼较宽浅, 近菱形, 表面具细平行条纹。 Seed-coat sculpture reticulate, lumina relatively broad and shallow, and nearly rhombic with fine parallel stripes on surface.	
3.4–5.3×3.5–5.0 ×3.5–5.5	种皮纹饰为网纹型, 网眼较宽浅, 近菱形, 表面具细平行条纹。 Seed-coat sculpture reticulate, lumina relatively broad and shallow, and nearly rhombic with fine parallel stripes on surface.	7, 10
3.2–5.4×3.7–5.5 ×3.5–5.5	种皮纹饰为网纹型, 网眼较宽浅, 近方形, 表面具细平行条纹; 脊细窄。 Seed-coat sculpture reticulate, lumina relatively shallow and broad, and nearly quadrate with fine parallel stripes on surface, muri narrow.	8, 11
3.5–5.0×3.5–5.2 ×3.5–5.4	种皮纹饰为网纹型, 网眼较宽浅, 近方形, 表面具细平行条纹; 脊细窄。 Seed-coat sculpture reticulate, lumina relatively shallow and broad, and nearly quadrate with fine parallel stripes on surface, muri narrow.	9, 12
4.2–6.5×4.5–6.3 ×4.8–6.6	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 表面光滑, 表皮细胞具清晰界线。 Seed-coat sculpture reticulate, muri narrow, lumina relatively shallow and broad with smooth surface, epidermal cell with pronounced borderline.	
3.1–5.4×3.2–5.5 ×3.2–5.5	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 表面光滑, 具细平行条纹, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow, lumina relatively shallow and broad with fine parallel stripe on smooth surface, epidermal cell with pronounced borderline.	
2.5–4.6×2.6–5.0 ×3.6–4.7	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 多边形, 表面具细平行条纹。 Seed-coat sculpture reticulate, muri narrow, lumina relatively broad and polygonal in shape with fine parallel stripes on surface.	13, 16
4.0–6.2×3.8–6.3 ×3.8–6.5	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 多边形, 表面具细平行条纹, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow, lumina relatively shallow and broad, and polygonal in shape with fine parallel stripes on surface, epidermal cell with pronounced borderline.	

表1 (续) **Table 1** (continued)

分类群 Taxon	采集地 Locality	凭证标本 Voucher	种子形状 Shape of seed
托柄菝葜 <i>S. discotis</i> Warb.	中国河南, 具体地点不详 Without precise locality, Henan, China	K. M. Lion 4866 (PE)	圆球形 spheroidal
黑果菝葜 <i>S. glauco-china</i> Warb.	中国广西桂林 Guilin, Guangxi, China	陈士超(S. C. Chen) 0304023 (HZU)	近球形 subspheroidal
黑叶菝葜 <i>S. nigrescens</i> Wang & Tang ex P. Y. Li	中国四川, 具体地点不详 Without precise locality, Sichuan, China	陈心启(S. C. Chen) 02023 (PE)	圆球形 spheroidal
鞘柄菝葜 <i>S. stans</i> Maxim.	中国云南苍山 Mt. Cangshan, Yunnan, China	俞德浚(T. T. Yu) 11317 (PE)	近球形 subspheroidal
糙柄菝葜 <i>S. trachypoda</i> Norton	中国陕西, 具体地点不详 Without precise locality, Shaanxi, China	李馨(Q. Li) 71114 (PE)	近球形 subspheroidal
合蕊菝葜 <i>S. cyclophylla</i> Warb.	中国四川峨眉山 Mt. Emeishan, Sichuan, China	关克俭(K. C. Kuan) 2756 (PE)	椭球形 ellipsoid
防己叶菝葜 <i>S. menispermoidea</i> A. DC.	中国云南屏边 Pingbian, Yunnan, China	邱炳云(B. Y. Qiu) 53633 (PE)	近球形 subspheroidal
青城菝葜 <i>S. tsinchengshanensis</i> Wang	中国四川青城山 Mt. Qingchengshan, Sichuan, China	邢公侠(K. H. Shing) 937 (PE)	圆球形 spheroidal
筐条菝葜 <i>S. corbularia</i> Kunth	中国广西龙州 Longzhou, Guangxi, China	傅承新(C. X. Fu) 91082 (HZU)	圆球形 spheroidal
粉背菝葜 <i>S. hypoglauca</i> Benth.	中国福建, 具体地点不详 Without precise locality, Fujian, China	钟补勤(P. C. Tsoong) 268 (PE)	圆球形 spheroidal
菱叶菝葜 <i>S. hayatae</i> T. Koyama	中国台湾, 具体地点不详 Without precise locality, Taiwan, China	台北帝国大学(Taipei Empire University) 19308 (PE)	近球形 subspheroidal
弯梗菝葜 <i>S. aberrans</i> Gagnep.	中国广东新县 Xin Xian, Guangdong, China	邓良(L. Deng) 1958, 0360701 (PE)	近球形 subspheroidal
平滑菝葜 <i>S. darrisii</i> Lévł.	中国四川, 具体地点不详 Without precise locality, Sichuan, China	郎楷永(K. Y. Lang) 870 (PE)	近球形 subspheroidal
无刺菝葜 <i>S. mairei</i> Lévł.	中国云南西山 Mt. Xishan, Yunnan, China	邱炳云(B. Y. Qiu) 51739 (PE)	圆球形 spheroidal
小叶菝葜 <i>S. microphylla</i> C. H. Wright.	中国陕西, 具体地点不详 Without precise locality, Shaanxi, China	钟补求(P. C. Tsoong) 3999 (PE)	圆球形 spheroidal
土茯苓 <i>S. glabra</i> Roxb.	中国云南麻栗坡 Malipo, Yunnan, China	王启无(C. W. Wang) 87158 (PE)	近球形 subspheroidal
乌饭叶菝葜 <i>S. myrtillos</i> A. DC.	中国广西龙胜 Longsheng, Guangxi, China	傅承新(C. X. Fu) 91041 (HZU)	近球形 subspheroidal

大小(长×宽×厚) Size (L×W×T) (μm)	种皮(纹饰)微形态特征 Micromorphological features of seed coat	图 Figure
3.5–5.4×4.0–5.6 ×4.0–5.5	种皮纹饰为网纹型, 脊轻微隆起, 网眼较宽浅, 多边形, 表面光滑, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri slightly raised, lumina relatively shallow and broad, and nearly polygonal in shape with smooth surface, epidermal cell with pronounced borderline.	
3.8–5.4×3.8–5.5 ×3.8–5.8	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 多边形, 表面具细平行条纹, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow, lumina relatively shallow and broad, and polygonal in shape with fine parallel stripes on surface, epidermal cell with pronounced borderline.	14, 17
3.7–5.5×3.7–5.5 ×3.7–5.7	种皮纹饰为脑纹型, 脊表面光滑。 Seed-coat sculpture rugulate, muri with smooth surface.	
4.0–6.2×3.5–6.0 ×3.5–6.4	种皮纹饰为孔穴型, 表面具细平行条纹, 孔穴圆形较小, 表皮细胞界线可见。 Seed-coat sculpture foveolate, with fine parallel stripes on surface, foveola rounded and relatively small, epidermal cell with pronounced borderline.	
3.5–6.0×3.5–6.1 ×3.4–5.9	种皮纹饰为网纹型, 脊细窄, 网眼较宽浅, 多边形, 表面具细平行条纹, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow, lumina relatively shallow and broad, and polygonal in shape with fine parallel stripes on surface, epidermal cell with pronounced borderline.	
3.8–6.0×4.1–6.3 ×3.6–5.8	种皮纹饰为孔穴型, 表面具细平行条纹, 孔穴稀疏较浅, 表皮细胞界线清晰。 Seed-coat sculpture foveolate, with fine parallel stripes on surface, foveola sparse and shallow, epidermal cell with pronounced borderline.	
4.0–6.2×3.9–6.0 ×4.0–6.5	种皮纹饰为细网纹型, 网脊较窄, 网眼较浅方形或多边形。 Seed-coat sculpture fine reticulate, muri relatively narrow, lumina relatively shallow and quadrate or polygonal in shape.	
3.8–5.7×3.8–5.8 ×3.8–6.1	种皮纹饰为脑纹型, 沟裂细深, 脊表面光滑, 宽度约40 μm。 Seed-coat sculpture rugulate, colpi deeply narrow in shape, muri ca. 40 μm wide with smooth surface.	15, 18
4.5–6.1×4.6–6.0 ×4.5–5.9	种皮纹饰为脑纹型, 沟裂细深, 脊表面光滑, 宽度约30 μm。 Seed-coat sculpture rugulate, colpi deeply narrow in shape, muri ca. 30 μm wide with smooth surface.	
5.8–6.2×5.8–6.0 ×5.8–6.3	种皮纹饰为脑纹型, 沟裂细深, 脊表面光滑, 宽度约50 μm。 Seed-coat sculpture rugulate, colpi deeply narrow in shape, muri ca. 50 μm wide with smooth surface.	
6.0–7.3×5.5–6.8 ×5.8–7.0	种皮纹饰为孔穴型, 孔穴近圆形, 较深较密, 种皮表面光滑。 Seed-coat sculpture foveolate, foveola relatively dense and deep, and rounded in shape, seed-coat surface smooth.	19, 22
6.2–7.5×7.0–8.0 ×6.4–7.6	种皮纹饰为脑纹型, 沟裂细深, 脊多少趋于平行, 表面光滑, 宽度约25 μm。 Seed-coat sculpture rugulate, colpi deeply narrow in shape, muri more or less tend to parallel, ca. 25 μm wide with smooth surface.	20, 23
3.5–5.0×3.2–5.0 ×3.2–5.0	种皮纹饰为网纹型, 网眼较浅, 近方形, 网脊较窄, 种皮表面皱缩状。 Seed-coat sculpture fine reticulate, lumina relatively shallow and nearly quadrate in shape, muri narrow, seed-coat surface crimp.	
3.8–5.5×3.8–5.6 ×3.7–5.5	种皮纹饰为网纹型, 网眼较浅, 近方形, 网脊较窄, 种皮表面皱缩状。 Seed-coat sculpture fine reticulate, lumina relatively shallow and nearly quadrate in shape, muri narrow, seed-coat surface crimp.	
3.0–4.5×3.0–5.0 ×3.0–5.0	种皮纹饰为细网纹型, 网脊纵横垂直, 网眼较深, 方形或多边形。 Seed-coat sculpture fine reticulate, muri vertically and horizontally interlaced, lumina relatively deep and nearly quadrate or polygonal in shape.	
3.0–5.0×3.0–5.0 ×3.0–5.2	种皮纹饰为孔穴型, 孔穴近圆形, 较密较深, 种皮表面光滑。 Seed-coat sculpture foveolate, foveola nearly rounded in shape, and dense and deep, seed-coat surface smooth.	
4.0–6.0×3.9–5.8 ×4.0–6.0	种皮纹饰为孔穴型, 孔穴近圆形, 较密较深, 种皮表面光滑。 Seed-coat sculpture foveolate, foveola nearly rounded in shape, and dense and deep, seed-coat surface smooth.	

表1 (续) **Table 1** (continued)

分类群 Taxon	采集地 Locality	凭证标本 Voucher	种子形状 Shape of seed
西南菝葜 <i>S. bockii</i> Warb.	中国云南屏边 Pingbian, Yunnan, China	邱炳云(B. Y. Qiu) 52520 (PE)	近球形 subspheroidal
缘脉菝葜 <i>S. nervo-marginata</i> Hayata	中国安徽, 具体地点不详 Without precise locality, Anhui, China	关克俭(K. C. Kuan) 75591 (PE)	近球形 subspheroidal
无疣菝葜 <i>S. nervo-marginata</i> Hayata var. <i>liukuensis</i> (Hay.) F. T. Wang & T. Tang	中国, 具体地点不详 Without precise locality, China	采集人不详 Anonymous	近球形 subspheroidal
马甲菝葜 <i>S. lanceifolia</i> Roxb.	中国云南屏边 Pingbian, Yunnan, China	王启无(C. W. Wang) 71996 (PE)	圆球形 spheroidal
凹脉菝葜 <i>S. lanceifolia</i> var. <i>impressinervia</i> (Wang & Tang) T. Koyama	中国, 具体地点不详 Without precise locality, China	采集人不详 Anonymous	近球形 subspheroidal
折枝菝葜 <i>S. lanceifolia</i> var. <i>elongata</i> (Warb.) Wang & Tang	中国, 具体地点不详 Without precise locality, China	采集人不详 Anonymous	圆球形 spheroidal
长叶菝葜 <i>S. lanceifolia</i> var. <i>lanceolata</i> (Norton) T. Koyama	中国云南屏边 Pingbian, Yunnan, China	王启无(C. W. Wang) 71996 (PE)	椭球形 ellipsoid
密疣菝葜 <i>S. chapaensis</i> Gagnep.	中国四川青城山 Mt. Qingchengshan, Sichuan, China	傅承新(C. X. Fu) 88302 (HZU)	椭球形 ellipsoid
束丝菝葜 <i>S. hemsleyana</i> Craib	中国云南文山 Wenshan, Yunnan, China	傅承新(C. X. Fu) 93043 (HZU)	近球形 subspheroidal
大果菝葜 <i>S. macrocarpa</i> Bl.	印度尼西亚爪哇岛 Java, Indonesia	陈士超(S. C. Chen)200501032 (HZU)	圆片形 extremely peroblate
疣枝菝葜 <i>S. aspericaulis</i> Wall. ex A. DC.	中国台湾, 具体地点不详 Without precise locality, Taiwan, China	汪发瓚, 唐进(F. T. Wang & T. Tang) 1116 (PE)	近球形 subspheroidal
银叶菝葜 <i>S. cocculoides</i> Warb.	中国贵州梵净山 Mt. Fanjingshan, Guizhou, China	傅承新(C. X. Fu) 91307 (HZU)	椭球形 ellipsoid
少花菝葜 <i>S. basilata</i> Wang & Tang	中国云南, 具体地点不详 Without precise locality, Yunnan, China	王启无(C. W. Wang) 85757 (PE)	近球形 subspheroidal
马钱叶菝葜 <i>S. lunglingensis</i> Wang & Tang	中国云南, 具体地点不详 Without precise locality, Yunnan, China	邱炳云(B. Y. Qiu) 52403 (PE)	近球形 subspheroidal
扁柄菝葜 <i>S. planipes</i> Wang & Tang	中国贵州, 具体地点不详 Without precise locality, Guizhou, China	傅承新(C. X. Fu) 93015 (HZU)	椭球形 ellipsoid
密刺菝葜 <i>S. densibarbata</i> Wang & Tang	中国云南屏边 Pingbian, Yunnan, China	王启无(C. W. Wang) 85452 (PE)	近球形 subspheroidal
密刚毛菝葜 <i>S. setiramula</i> Wang & Tang	中国云南西畴 Xichou, Yunnan, China	陈士超(S. C. Chen)20030132 (HZU)	近半球形 semi-spheroidal

大小(长×宽×厚) Size (L×W×T) (μm)	种皮(纹饰)微形态特征 Micromorphological features of seed coat	图 Figure
4.8–6.0×4.1–6.2 ×4.4–6.0	种皮纹饰为脑纹型, 沟裂较深, 脊宽度约70 μm, 表面光滑。 Seed-coat sculpture rugulate, colpi relatively deep in shape, muri ca. 70 μm wide and with smooth surface.	21, 24
4.0–6.2×3.4–5.8 ×3.4–5.5	种皮纹饰为网纹型, 脊窄密集, 多少平行, 网眼浅, 近方形, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow and dense, and more or less parallel, lumina relatively shallow and nearly quadrate in shape, epidermal cell with legible borderline.	
3.5–5.0×4.0–6.0 ×4.0–6.0	种皮纹饰为网纹型, 脊窄密集, 纵横垂直, 网眼浅, 近方形, 表皮细胞界线清晰。 Seed-coat sculpture reticulate, muri narrow and dense, and horizontal and vertical array each other, lumina relatively shallow and nearly quadrate in shape, epidermal cell with legible borderline.	
4.5–6.5×4.5–6.0 ×4.5–5.8	种皮纹饰为密孔穴型, 孔穴近圆形, 较密, 种皮表面呈皱缩状。 Seed-coat sculpture dense foveolate, foveola dense and nearly rounded in shape, seed-coat surface crimp.	25, 28
3.0–5.2×3.0–4.8 ×3.2–5.4	种皮纹饰为密孔穴型, 孔穴近圆形, 较密; 种皮表面光滑, 具相互垂直的条纹。 Seed-coat sculpture dense foveolate, foveola dense and rounded in shape, seed-coat surface smooth with vertically and horizontally interlaced stripes.	
3.5–5.5×3.5–5.0 ×3.5–5.0	种皮纹饰为网纹型, 网眼多边形较浅, 宽约80 μm, 网脊光滑。 Seed-coat sculpture reticulate, lumina nearly polygonal and relatively shallow, and ca. 80 μm wide, muri with smooth surface.	
3.0–4.5×2.8–3.5 ×3.0–5.0	种皮纹饰为网纹型, 网脊稍宽, 网眼不规则。 Seed-coat sculpture reticulate, muri relatively broad, lumina irregular in shape.	
6.8–8.0×7.2–9.0 ×6.8–8.2	种皮纹饰为细网纹型, 网脊光滑, 网眼较浅, 近圆形, 宽约40 μm, 种皮表面呈皱缩状。 Seed-coat sculpture fine reticulate, muri smooth, lumina relatively shallow and nearly round in shape, ca. 40 μm wide, seed-coat surface crimp.	26, 29
4.5–6.0×4.5–6.5 ×4.5–6.5	种皮纹饰为网纹型, 网眼较浅, 具平行细条纹。 Seed-coat sculpture reticulate, lumina relatively shallow with fine parallel stripes.	
7.1–9.0×8.2–9.5 ×2.8–4.5	种皮纹饰为细条纹型, 表面具平行细条纹, 间距约25 μm, 表皮细胞界线可见。 Seed-coat sculpture fine reticulate, seed-coat surface with fine parallel stripes, space between of strips ca. 25 μm, epidermal cell with borderline.	31
4.5–6.5×4.2–6.5 ×4.0–6.8	种皮纹饰为脑纹型, 脊表面光滑, 高度起伏变化 Seed-coat sculpture regulate, muri with smooth surface and variational in height.	
4.2–6.5×3.0–6.0 ×3.4–5.0	种皮纹饰为脑纹型, 沟裂细窄, 较深, 脊表面光滑, 宽约50 μm Seed-coat sculpture rugulate, colpi relatively narrow and deep in shape, muri ca. 50 μm wide and with smooth surface.	34
5.2–7.0×4.8–6.8 ×4.8–7.0	种皮纹饰为网纹型, 网眼浅, 多边形, 宽约100 μm, 网脊窄, 相互垂直排列, 表皮细胞界线突起可见。 Seed-coat sculpture reticulate, lumina shallow and polygonal in shape, ca. 100 μm wide, muri narrow and vertically and horizontally interlaced, epidermal cell with projecting borderline.	35
2.9–5.5×2.9–5.6 ×2.8–5.8	种皮纹饰为孔穴型, 孔穴圆形, 种皮表面光滑, 表皮细胞界线处凹陷 Seed-coat sculpture foveolate, foveola rounded, seed-coat surface smooth with sunken borderline of epidermal cell.	33
7.0–9.0×6.5–9.0 ×6.0–8.2	种皮纹饰为网纹型, 网脊窄, 纵横垂直, 网眼较浅, 近方形, 表皮细胞界线明显可见。 Seed-coat sculpture reticulate, muri vertically and horizontally interlaced, lumina relatively shallow and nearly quadrate, epidermal cell with pronounced borderline.	
5.7–8.0×5.5–7.8 ×5.5–7.5	种皮纹饰为网纹型, 网脊表面光滑, 相互垂直, 网眼浅近方形。 Seed-coat sculpture reticulate, muri vertically and horizontally interlaced, lumina relatively shallow and nearly quadrate.	
3.5–5.5×3.6–5.4 ×3.6–5.8	种皮纹饰为细条纹型, 表面具平行细条纹, 间距约15 μm。 Seed-coat sculpture fine striate, with fine parallel stripes, space between stripes ca. 15 μm.	32

表1 (续) **Table 1** (continued)

分类群 Taxon	采集地 Locality	凭证标本 Voucher	种子形状 Shape of seed
穿鞘菝葜 <i>S. perfoliata</i> Lour.	中国广东阳山县 Yangshan, Guangdong, China	邓良(L. Deng) 1543 (PE)	近球形 subspheroidal
穗菝葜 <i>S. aspera</i> L.	中国云南, 具体地点不详 Without precise locality, Yunnan, China	蔡希陶(H. T. Tsai) 045478 JSBI (PE)	圆球形 spheroidal
四棱菝葜 <i>S. polycephala</i> Wang & Tang	中国云南屏边 Pingbian, Yunnan, China	傅承新(C. X. Fu) 91396 (HZU)	圆球形 spheroidal
<i>S. rotundifolia</i> Bello	美国, 具体地点不详 Without precise locality, America	Anonymous	近半球形 semi-spheroidal
<i>S. pumila</i> Walter	美国, 具体地点不详 Without precise locality, America	Anonymous	椭球形 ellipsoid
<i>S. australis</i> R. Br.	新西兰, 具体地点不详 Without precise locality, New Zealand	Anonymous	近半球形 semi-spheroidal

对用于扫描电镜观察的样品, 将处理后的种子用导电胶粘在样品台上, 经离子溅射仪喷涂厚约2.3 nm的金膜后, 置于KYKY-1000B型扫描电镜下观察并照相, 扫描部位皆为种子侧面中央部分。

2 观察结果

2.1 菝葜科植物种子的特征

菝葜科植物种子有多种形状, 如球形、椭球形、半球形和扇球形(钝三角形)等。种子大小相差悬殊, 最大的平均值为8.5×8.5×8.7 mm(见于四棱菝葜), 最小的平均值为3.5×3.6×3.2 mm(见于马钱叶菝葜)。种子颜色为红色及黑色, 外种皮坚硬, 不易变形。部分种子背部具浅纵沟。种脐圆形微突, 通常为种子直径的1/3左右, 与种皮接合处有明显界线。种皮在接近种脐处有一浅环形凹陷, 形成种脐的颈部。合点通常位于种脐相对部位, 直径较小, 圆形凹陷, 中间略有突起。种皮纹饰除种脐和合点处, 其余部位较为一致, 只是在近合点处的纹饰常出现放射聚合状。在光学显微镜下观察, 种皮表面有皱纹、孔状凹陷或条纹。在扫描电镜下观察, 种皮纹饰可分为7种类型: 脑纹型、粗脑纹型、网纹型、细网纹型、孔穴型、密孔穴型和细条纹型。

每种植物种子的形态及种皮微形态特征详见表1、图1–36。

2.2 菝葜属的种子特征

本研究观察了菝葜属49种5变种的种子形态和种皮纹饰(图6–36)。本属种子为球形、椭球形或近半球形, 大小变化范围较大, 最大的四棱菝葜种子为7.5–9.0×7.5–8.5×7.4–8.5 mm, 最小的马钱叶菝葜种子为2.9–5.5×2.9–5.6×2.8–5.8 mm。部分种子背部具凹陷的浅纵沟。菝葜属植物种类多, 种皮表面纹饰变化也较大, 包括6种纹饰类型: 脑纹型、

大小(长×宽×厚) Size (L×W×T) (μm)	种皮(纹饰)微形态特征 Micromorphological features of seed coat	图 Figure
4.5–6.5×3.0–5.0×3.5–5.5	种皮纹饰为孔穴型，孔穴近圆形，种皮表面光滑，具轻微平行条纹，表皮细胞界线可见。 Seed-coat sculpture foveolate, foveola nearly rounded, seed-coat surface smooth with slight parallel stripes, epidermal cell with pronounced borderline.	27, 30
3.5–5.4×3.5–5.5×3.5–5.5	种皮纹饰为细条纹型，表面具平行细条纹，间距约25 μm，表皮细胞界线可见。 Seed-coat sculpture fine striate, with fine parallel stripes, space between stripes ca. 25 μm, epidermal cell with pronounced borderline.	36
7.5–9.0×7.5–8.5×7.4–8.5	种皮纹饰为孔穴型，孔穴近圆形，种皮表面光滑，具凹陷的表皮细胞界线。 Seed-coat sculpture foveolate, foveola nearly rounded, seed-coat surface smooth, epidermal cell with sunk borderline.	
4.3–6.5×4.0–6.4×4.2–6.5	种皮纹饰为细条纹型，表皮细胞近长方形，界线处凹陷。 Seed-coat sculpture fine striate, epidermal cell nearly rectangular in shape and with sunk borderline.	
3.5–5.5×2.8–4.8×2.8–5.0	种皮纹饰为网纹型，网脊宽度不规则变化，表面光滑，网眼较小，近方形。 Seed-coat sculpture reticulate, muri smooth with irregular breadth, lumina nearly quadrate and relatively small.	
4.8–7.0×5.0–7.5×4.9–7.5	种皮纹饰为细条纹型，表面具平行细条纹，间距约15 μm。 Seed-coat sculpture fine striate, with fine parallel stripes, space between stripes ca. 15 μm.	

网纹型、细网纹型、孔穴型、密孔穴型和细条纹型。

按照Koyama(1960)的分组，分别描述各组的种皮纹饰变化如下。

2.2.1 草本组sect. *Coprosmanthus* Torrey 观察3种1变种。其中亚洲草本种类的种皮纹饰都为脑纹型，脑纹的脊表面光滑，有时具圆形小颗粒或平行条纹，宽度约为50 μm；通常沟裂狭窄较深(只有变种尖叶牛尾菜的沟裂较浅)，不规则曲线形，种子表皮细胞界线不可见，如牛尾菜(图3, 6)。但是北美草本种*S. herbacea*种子表皮纹饰为细网纹型，网脊纵横交织，形成近似方形的网眼，网眼大小约25 μm，明显比其他网纹型密集。

2.2.2 菝葜组sect. *China* T. Koyama 观察13种。该组种皮纹饰均为典型的网纹型(图7–17)，只有华东菝葜和短梗菝葜例外，它们的种皮纹饰为孔穴型。典型的网纹型网眼为方形或多边形，宽度约为100 μm，表面有4–7条微隆起的平行条纹；网脊较狭窄，如线状隆起，纵横交织；多数种类的表皮细胞界线清晰可见。华东菝葜和短梗菝葜的种皮纹饰与该组的多数种类不一致，这两种都为孔穴型种皮纹饰。种皮表面较光滑，孔穴为近圆形凹陷，较为密集；表皮细胞界线可见。

2.2.3 土茯苓组sect. *Coilanthus* A. DC. 观察16种1变种。该组种皮纹饰变化较大，包括脑纹型、孔穴型、网纹型3种类型。其中脑纹型的种类最多，青城菝葜(图15, 18)种皮的脑纹最为清晰，沟裂窄深，脊隆起明显，表面光滑。弯梗菝葜(图20, 23)种皮纹饰中的脊多少有些平行排列。小叶菝葜的脑纹较为特殊，脊宽度较小，排列较密，并且多少有些纵横交错排列。土茯苓的种皮纹饰不是很典型的脑纹型，有点接近孔穴型。该组中除了脑纹型还有少数几种的种皮纹饰为网纹型(如：缘脉菝葜、糙柄菝葜等)和孔穴型(鞘柄菝葜和菱叶菝葜(图19, 22))。

2.2.4 圆锥组sect. *Macranthae* Kunth 观察12种3变种。该组种皮纹饰变化最大，包括了网纹型、孔穴型、密孔穴型、细条纹型和脑纹型5种类型，而且种子大小变化很大。其中

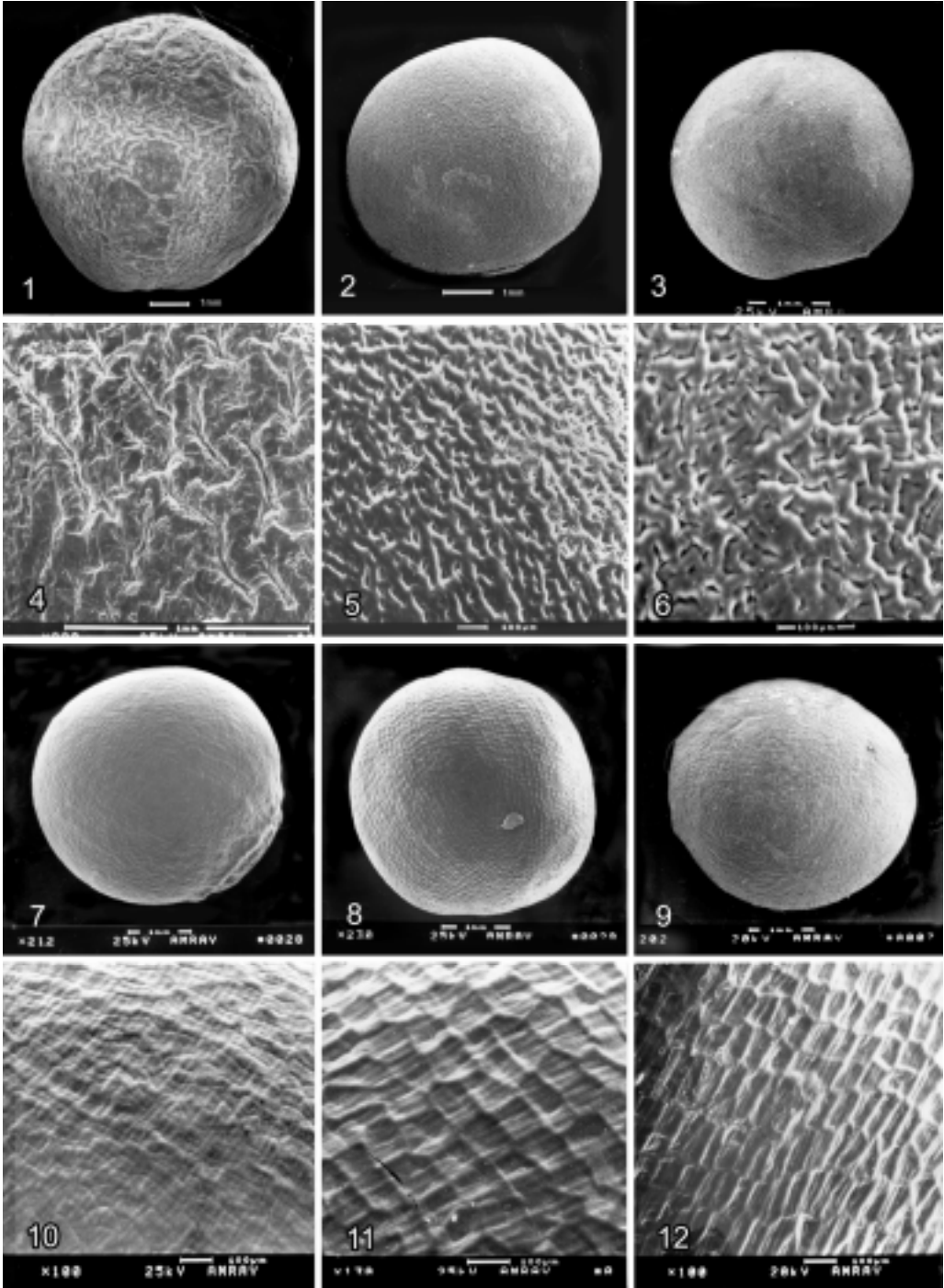


图1-12 扫描电镜下菝葜科种子形态及种皮微形态 1, 4. 类菝葜。2, 5. 肖菝葜。3, 6. 牛尾菜。7, 10. 菝葜。8, 11. 日本菝葜。9, 12. 三脉菝葜。
Figs. 1-12. SEM photographs of seeds and seed-coat in Smilacaceae. 1, 4. *Ripogonum discolor* F. Muell. 2, 5. *Heterosmilax japonica* Kunth. 3, 6. *Smilax riparia* A. DC. 7, 10. *S. china* L. 8, 11. *S. biflora* Siebold ex Miq. 9, 12. *S. trinervula* Miq.

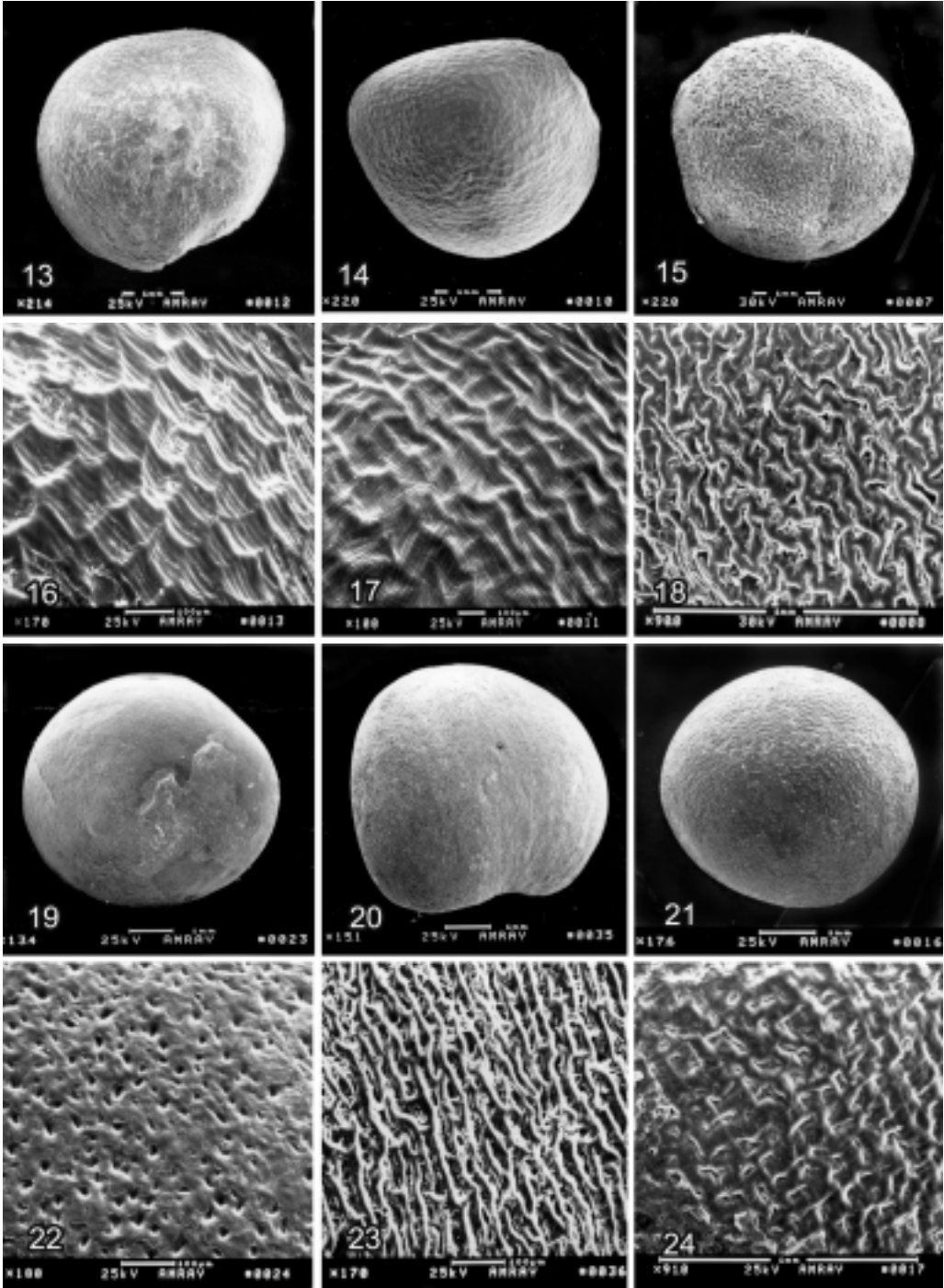


图13-24 扫描电镜下菝葜科种子形态及种皮微形态 13, 16. 红果菝葜。14, 17. 黑果菝葜。15, 18. 青城菝葜。19, 22. 菱叶菝葜。20, 23. 弯梗菝葜。21, 24. 西南菝葜。
Figs. 13-24. SEM photographs of seeds and seed-coat in Smilacaceae. 13, 16. *S. polycolea* Warb. 14, 17. *S. glauco-china* Warb. 15, 18. *S. tsinchengshanensis* Wang. 19, 22. *S. hayatae* T. Koyama. 20, 23. *S. aberrans* Gagnep. 21, 24. *S. bockii* Warb.

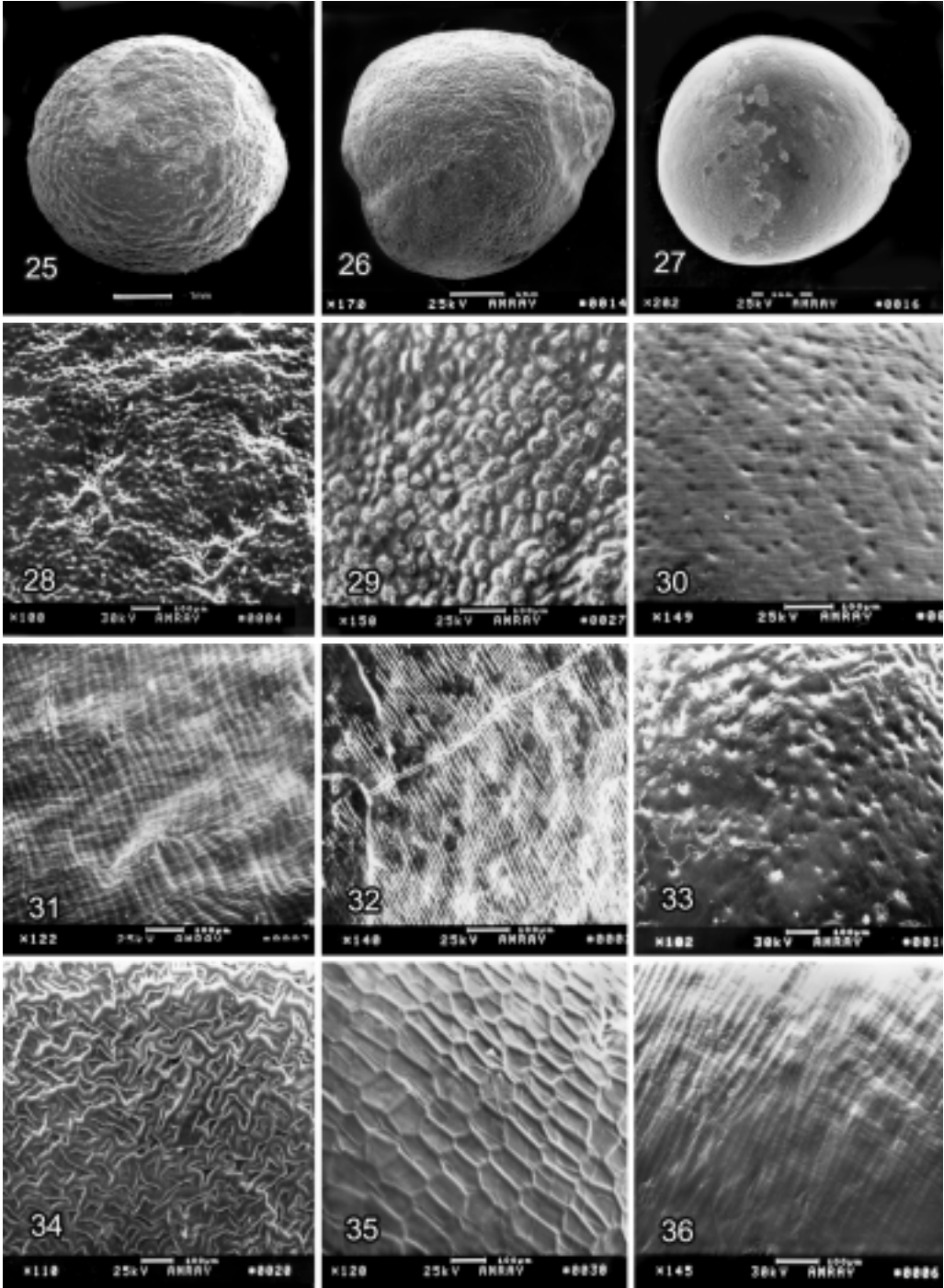


图25-36 扫描电镜下菝葜科种子形态及种皮微形态 25, 28. 马甲菝葜。26, 29. 密疣菝葜。27, 30. 穿鞘菝葜。31. 大果菝葜。32. 密刚毛菝葜。33. 马钱叶菝葜。34. 银叶菝葜。35. 少花菝葜。36. 穗菝葜。
Figs. 25-36. SEM photographs of seeds and seed-coat in Smilacaceae. 25, 28. *S. lanceifolia* Roxb. 26, 29. *S. chapaensis* Gagnep. 27, 30. *S. perfoliata* Lour. 31. *S. macrocarpa* Bl. 32. *S. setiramula* Wang & Tang. 33. *S. lunglingensis* Wang & Tang. 34. *S. cocculoides* Warb. 35. *S. basilata* Wang & Tang. 36. *S. aspera* L.

最小的马钱叶菝葜种子纹饰为孔穴型(图33), 直径较大的密刺菝葜种皮纹饰为网纹型。该组中马甲菝葜种皮为密孔穴型(图25, 28)。穿鞘菝葜种皮为孔穴型(图27, 30)。少花菝葜(图35)和密疣菝葜(图26, 29)的种皮纹饰为网纹型, 和菝葜组中的大多数种类相近。而银叶菝葜(图34)则出现了和青城菝葜(图15, 18)极为近似的脑纹型种皮纹饰。

2.2.5 穗菝葜组sect. *Smilax* (= sect. *Eusmilax* A. DC.) 该组只有2个种, 都进行了观察。穗菝葜种皮纹饰为细条纹型(图36), 种皮表面有很浅的圆形凹陷, 但是明显比孔穴型光滑; 有近似平行的略凸条纹; 表皮细胞界线清晰, 细胞长轴和略凸条纹相垂直。四棱菝葜的种子很大, 种皮纹饰为孔穴型, 表面光滑, 孔穴近圆形, 较密集, 与穗菝葜区别明显。

2.3 肖菝葜属植物种子特征

肖菝葜属观察3种。种子为球形或近球形, 中等大小, 3.8–5.5×4.3–6.6×3.5–5.8 mm, 有些种子背部具凹陷的浅纵沟。该属种皮纹饰较为一致, 均为脑纹型, 脊表面光滑, 宽度约为60 μm, 表皮细胞界线不见, 例如肖菝葜(图2, 5)。

2.4 类菝葜属植物种子特征

类菝葜属观察1种。类菝葜的种子为近球形, 相对较大, 6.0–8.0×5.8–7.6×6.2–8.3 mm。种脐轻度凹陷, 合点稍大, 种子外形上没有浅纵沟。光镜下可见种子表面粗糙。电镜下可见种皮纹饰为粗脑纹型(图1, 4), 沟裂窄深, 近线形; 脊宽大, 宽约120 μm, 表面具不规则波纹; 容易与其他类型的表皮纹饰区分开。

3 讨 论

菝葜科种子的形状及颜色多样, 大小相差悬殊, 这些形态特征在种内也不十分稳定。菝葜属中每个小浆果内含1–3(–5)枚种子, 若为1枚种子时则通常为球形或近球形, 而2枚或3枚及多枚时则由于种子间相互挤压而形成多种形状。种子背部凹陷的浅纵沟也是不稳定的特征, 在同一果实中也发现有些种子有纵沟, 而另一些却没有。种皮颜色变化较大, 从浅红色、红色、棕色至黑色都有。因此这些形态特征在种类的鉴别上意义不大。

在扫描电镜下观察, 菝葜科种皮微形态的变异式样丰富, 包括粗脑纹型、脑纹型、网纹型、细网纹型、孔穴型、密孔穴型、细条纹型等7种类型的种皮纹饰。这些种皮微形态的变化可以为菝葜科的系统发育研究提供新的证据。

3.1 科的界定和属间关系的探讨

菝葜科是否应包括*Ripogonum*属一直存在争议, Conran(1985)对单子叶网状脉类群的表征分类学研究认为*Ripogonum*与菝葜科其余种类区别明显, 可能亲缘关系较远, 建议将该属分类地位提升, 独立成Ripogonaceae科; 分子系统学的研究提示该属可能与Philesiaceae科的亲缘关系更为紧密(Rudall et al., 2000; Vinnersten & Bremer, 2001; Cameron & Fu, in press); 此外, 该属花粉与菝葜科常见的球形无孔类型不同, 为独特的椭球形单沟网纹型(Chen et al., 2006)。根据本研究观察, 类菝葜属的种子很大, 种皮纹饰呈现出独有的粗脑纹型, 明显区别于该科其他属的所有种类。所以根据种皮微形态的特征、花粉形态特征以及分子系统学研究结果, 均支持将*Ripogonum*属从菝葜科中分离出来, 独立成科的观点。

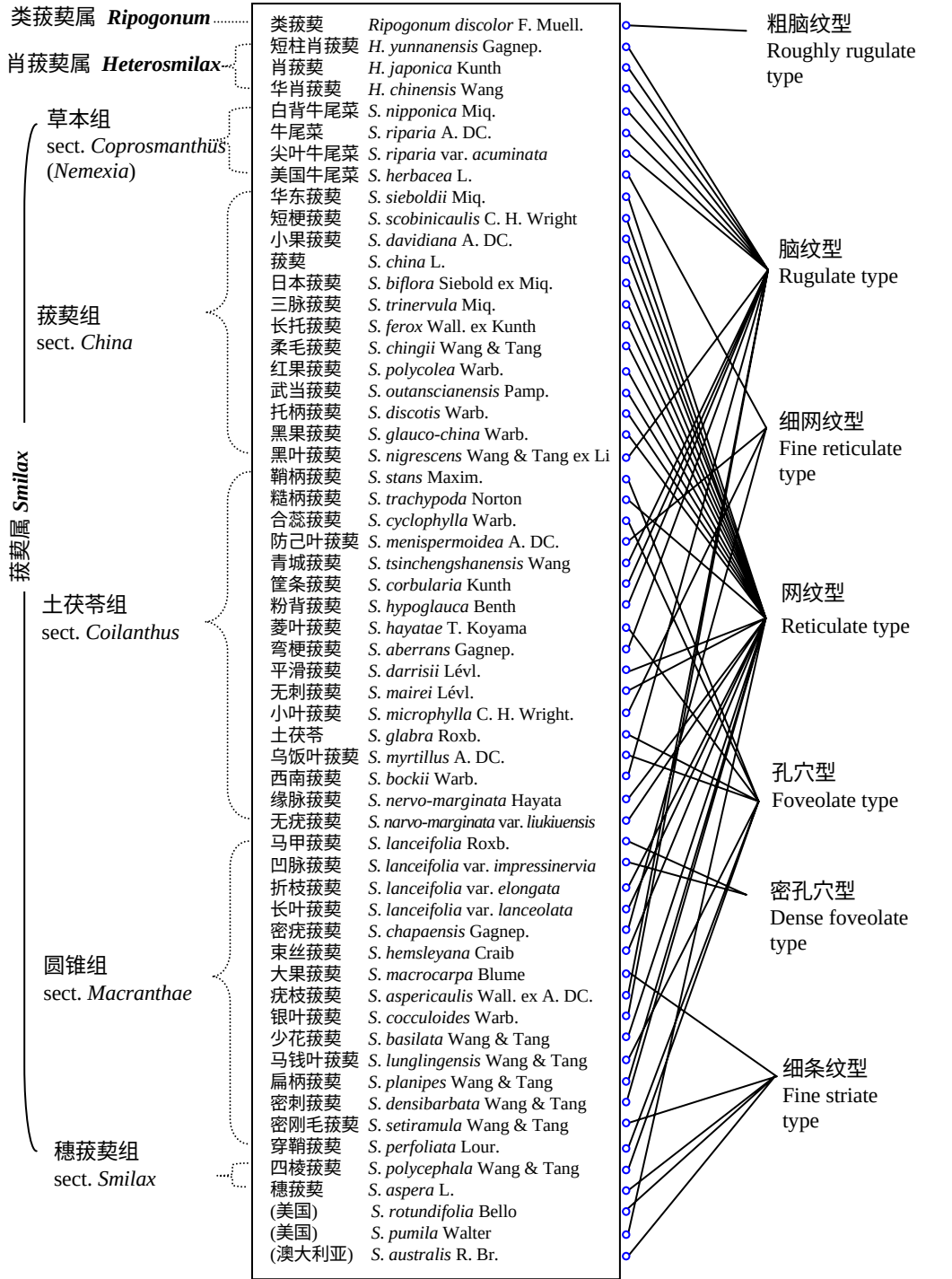


图37 菝葜科种皮纹饰类型与菝葜属分组的对应关系图示

Fig. 37. The microstructural features of seed surface corresponding to the sections of *Smilax* in Smilacaceae.

肖菝葜属最早是由de Candolle(1878)根据花被融合特征提出的。Koyama(1984)对该属做了修订, 包括了12个种, 认为其分布区在亚洲东部和东南亚地区, 并指出花粉具脑纹状的纹饰是该属的共有特点。但是根据Chen等(2006)对菝葜科系统的孢粉学研究表明, 脑状纹饰并不是该属独有的特征, 菝葜属的部分种类也具有相同的纹饰类型。根据本文对种皮微形态的研究表明, 该属被观察种类的种皮纹饰均为脑纹型, 也与菝葜属相当多的种类相同, 所以在种皮的微形态特征上肖菝葜属与菝葜属同样不存在间断。对该科的分支分类研究显示(Chen et al., 2006), 该属的分类地位并不科学, 应包括在菝葜属内。分子系统学的研究显示了更为直接的证据(Cameron & Fu, 2006), 明确指出该属被包含在菝葜属不同的分支上, 不是单系类群。因此, 综合多方面的证据我们支持将其并入菝葜属。

3.2 菝葜属属内关系的探讨

菝葜属是菝葜科最大的属, 包括了该科的绝大多数种类(约占95%), 但是至今尚无完整的修订或专著发表, 种的划分较为混乱, 种间关系不明确。Koyama(1960)将亚洲的菝葜属分为6个组: 多蕊菝葜组sect. *Pleiosmilax*、穗菝葜组sect. *Smilax*、圆锥组sect. *Macranthae*、土茯苓组sect. *Coilanthus*、菝葜组sect. *China*和草本组sect. *Coprosmanthus*。本研究观察了该属49种5变种, 发现其种皮纹饰变化十分丰富, 包括了6种不同的纹饰类型, 但是它们无法与Koyama划分的组相吻合。根据种皮纹饰类型的变化, 各组间不能截然分开, 均有明显的交叉和过渡类型(图37), 不能作为组的鉴别性状。在本文观察过的种类中, 脑纹型和网纹型是两大主要类型, 尤以网纹型包含的种类最多。菝葜属的草本组和土茯苓组的大多数种类, 以及肖菝葜属所有种类都是脑纹型种皮纹饰, 暗示它们可能亲缘关系较近; Koyama(1984)曾根据肖菝葜属和土茯苓组的花粉形态比较接近, 也指出它们亲缘关系较近; Chen等(2006)最近对全科的孢粉学研究也显示出相同的结果。而菝葜组和圆锥组的绝大多数种类都属网纹型种皮纹饰, 表明菝葜组和圆锥组的大多数种类亲缘关系较为密切, 这与形态分支分类研究结果相一致。陈士超等(2006)对该科形态分支分类研究结果显示, 这两个组亚洲分布的多数种类聚在同一个分支上, 表明它们为单系起源、相互间亲缘关系紧密。其余4种纹饰类型都只包括较少的种类, 而且分散在不同的组内, 显示出菝葜属内复杂的种间演化关系, 尚需进一步的研究才能揭示。

综上所述, 根据种皮微形态微结构特征的观察分析, 并结合前人花粉形态、形态学分支分类和分子系统学的研究, 笔者提出如下观点: 1)支持将*Ripogonum*属从菝葜科中分离出来, 成立Ripogonaceae科; 2)支持将肖菝葜属并入菝葜属内, 成立肖菝葜亚属; 3)赞同菝葜属内的分组并非自然单系的观点。根据以上结论, 菝葜科将变为单属科, 只包含菝葜属。该属种类多、分布广, 种的鉴定困难, 种间系统发育关系复杂, 尚存在较多的分类学问题; 而该属种皮微形态的丰富变化, 提供了重要的系统发育信息。虽然作者在取样时注意收集了菝葜科所有的属和组的代表种类, 基本反映出了该科种皮纹饰特征的全貌, 但由于取样局限, 南、北美洲的种类研究较少, 今后尚需补充该地区的材料进一步研究。

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